

WHAT IS CLAIMED IS:

1 A method for suturing a puncture through a vessel wall of a blood
2 vessel, the puncture disposed within a tissue tract of a patient body, the method
3 comprising:

4 attaching a flexible filament to a first fitting;
5 inserting the first fitting through the tissue tract and positioning the first
6 fitting adjacent the vessel wall;
7 forming a needle path by advancing a first needle through the vessel wall
8 outside the puncture;
9 coupling the needle with the first fitting; and
10 withdrawing the first needle, the first fitting, and at least a first portion of
11 the filament through the vessel wall along the needle path.

1 2. The method of claim 1, further comprising:
2 coupling the flexible filament to a second fitting;
3 positioning the second fitting adjacent the vessel wall so that the puncture
4 is disposed between the first positioned fitting and the second positioned fitting;
5 advancing a second needle through the vessel wall and into engagement
6 with the second fitting.

1 3. The method of claim 2, further comprising withdrawing the second
2 needle and the second fitting through the vessel wall, wherein the filament coupling steps
3 affix a first end of suture to the first fitting and a second end of the suture to the second
4 fitting so that the withdrawing steps form a suture loop across the puncture.

1 4. The method of claim 3, wherein the withdrawing steps draw the
2 suture from within the blood vessel out through the vessel wall.

1 5. The method of claim 2, wherein the first and second positioning
2 steps comprise introducing the fittings through the puncture, and wherein the first and
3 second needle advancing steps comprise inserting the needles into the vessel so as to
4 engage the fittings therein.

1 6. The method of claim 5, wherein the fittings are supported near a
2 distal end of a shaft during the introducing step, and wherein the first and second
3 positioning steps further comprise displacing the fittings laterally from the shaft.

1 7. The method of claim 6, wherein the displacing step comprises
2 articulating an elongate foot within the vessel so that the foot moves from a low profile
3 configuration aligned along the shaft to a deployed configuration extending laterally from
4 the shaft and along the blood vessel, the fittings being releasably mounted near first and
5 second ends of the foot.

1 8. The method of claim 7, further comprising pulling the deployed
2 foot proximally against an interior surface of the vessel wall after the deploying step.

1 9. The method of claim 8, further comprising verifying that the foot is
2 disposed within the vessel prior to the displacing step by monitoring a sensor adjacent the
3 foot.

1 10. The method of claim 7, wherein the articulating step comprises
2 sliding at least a portion of the foot axially along the shaft.

1 11. The method of claim 7, wherein the articulating step comprises
2 pivoting the foot away from an axial orientation.

1 12. The method of claim 2, wherein the second advancing step passes
2 suture through the vessel wall and couples the suture to the second fitting.

1 13. The method of claim 12, wherein the withdrawing step draws the
2 first fitting, the filament, the second fitting, and a portion of the suture through the vessel
3 wall along a needle path of the first needle.

1 14. The method of claim 13, further comprising forming a loop of the
2 suture, wherein the withdrawing step draws the portion of the suture through the loop to
3 help form a suture knot.

1 15. The method of claim 1, wherein the first fitting defines an opening
2 and a latch, and further comprising attaching the fitting to the needle by latching the
3 needle into the opening of the fitting.

1 16. The method of claim 15 wherein the needle has a recess and the
2 fitting comprises a substantially cylindrical cuff having at least one tab extending therein,
3 and wherein the advancing step deflects the at least one tab when the needle is received in
4 the opening, the at least one tab resiliently flexing into the recess to secure the fitting to
5 the needle.

1 17. The method of claim 15, further comprising directing a needle into
2 the opening with a guide surface around the opening, the needle being flexible.

1 18. The method of claim 1, wherein the first needle withdraws said at
2 least a portion of the flexible element without threading the flexible element into the
3 needle.

1 19. A method for suturing an opening in a tissue, the method
2 comprising:
3 inserting a distal end of a probe through the opening, the probe defining a
4 probe axis;
5 articulating an elongate foot of the probe so that first and second ends of
6 the foot extend laterally with the opening aligned therebetween;
7 forming a first needle path from the probe through the tissue and to the
8 first end of the foot;
9 forming a second needle path from the probe through the tissue and to the
10 second end of the foot;
11 advancing suture along the first and second needle paths to position a
12 suture loop across the opening.

1 20. The method of claim 19, wherein the tissue comprises a blood
2 vessel having an axis, wherein the articulating step is performed so that the articulated
3 foot extends along the vessel axis within the vessel.

1 21. The method of claim 19, wherein the first and second needle path
2 forming steps comprise deflecting first and second flexible needles at an angle relative to
3 the probe axis and advancing the needles in cantilever radially outwardly from first and
4 second fixed needle guides of the probe to the first and second ends of the articulated

5 foot, the first and second ends of the articulated foot being separated laterally relative to
6 the probe axis by a greater distance than the first and second needle guides.

1 22. The method of claim 19, wherein the articulating step comprises
2 pulling a flexible element proximally so that the flexible element slides the foot
3 proximally along the probe axis and so that the foot pivots laterally within the blood
4 vessel.

1 23. The method of claim 19, further comprising inserting the foot
2 through the puncture prior to the articulating step and pulling the shaft proximally after
3 the articulating step so that the first and second ends of the deployed foot firmly engage
4 the tissue beyond the puncture.

1 24. A method for suturing a blood vessel, the vessel having a vessel
2 wall, the method comprising:

3 advancing a shaft toward the vessel wall, the shaft having an axis and a
4 plurality of needle guides;
5 deploying a foot adjacent the vessel wall so that the foot extends laterally
6 from the shaft;

7 advancing a plurality of needles from needle guides of the shaft to the foot
8 to form needle paths through the vessel wall, the needle guides deflecting the needles
9 laterally so that a needle path width is greater than a cross-sectional dimension of the
10 shaft; and

11 advancing suture along the needle paths to position at least one suture loop
12 across the puncture.

1 25. The method of claim 24, wherein the needles are flexible and the
2 needle guides are fixed, and further comprising directing the needles laterally into secure
3 engagement with fittings disposed releasably on the foot with a tapering needle receptacle
4 surface of the foot.

1 26. A method for suturing a puncture of a blood vessel through a tissue
2 tract of a patient body, the vessel having a vessel wall, the method comprising:
3 inserting a distal end of the probe through the puncture and into the blood
4 vessel;

5 advancing a first end of the suture from the probe within the tissue tract,
6 through the vessel wall, and into the vessel;
7 withdrawing the first end of the suture from the vessel, through the vessel
8 wall and through a bight of the suture to form a loop of suture across the puncture; and
9 tensioning the first end of the suture and a second end of the suture
10 adjacent the bight to form a knot affixing the loop of suture across the puncture.

1 27. The method of claim 26, further comprising releasably attaching
2 the bight of suture to a probe before the inserting step, wherein the tensioning step
3 detaches the bight from the probe.

1 28. A system for suturing a blood vessel, the vessel having a vessel
2 wall, the system comprising;
3 a needle having a proximal end and a distal end suitable for forming a
4 needle path through the vessel wall, the needle having a recessed engagement surface
5 adjacent the distal end;
6 a flexible filament; and
7 a fitting attached to the filament, the fitting having an opening and at least
8 one tab extending into the opening, the tab securely engaging the engagement surface
9 when the needle advances through the vessel wall and into the opening so that the fitting
10 and at least a portion of the filament can be withdrawn proximally along the needle path
11 by the needle.

1 29. The system of claim 28, wherein the at least one tab resiliently
2 deflects into an indentation adjacent the engagement surface when the needle advances
3 into the opening.

1 30. The system of claim 29, wherein the fitting comprises a tube
2 having a proximal end and a distal end, the opening extending into the proximal end, the
3 at least one tab formed of tube material by cutting slots through the tube, wherein the
4 filament comprises suture extending distally from the distal end of the tube.

1 31. The system of claim 30, wherein the fitting further comprises a
2 collar disposed about the suture, the collar crimped over an end of the suture.

1 32. The system of claim 28, wherein the fitting is mounted on a foot
2 near a distal end of a probe, the probe having a handle near a proximal end of the probe,
3 actuation of the handle effecting articulation of the foot so that the fitting moves laterally
4 from an axis of the probe.

1 33. The system of claim 28, wherein the needles are flexible, and
2 wherein the fitting is releasably supported within a receptacle surface oriented to laterally
3 deflect the advancing needle toward the fitting.

1 34. The system of claim 33, wherein the receptacle surface tapers from
2 a small cross-section adjacent the fitting to a large cross-section oriented toward the
3 advancing needle.

1 35. The system of claim 33, further comprising a slot disposed along
2 the receptacle surface, wherein the filament is releasably disposed in the slot, the slot
3 configured to avoid engagement of the needle with the suture.

1 36. The system of claim 35, wherein the slot has a cross-section
2 smaller than the needle.

1 37. A system for suturing a puncture of a blood vessel within a tissue
2 tract, the vessel having a vessel wall and defining an axis, the system comprising:
3 a shaft having a proximal handle and a distal end suitable for insertion
4 along the tissue tract and into the vessel through the puncture;
5 a foot mounted near the distal end of the shaft, the foot having a plurality
6 of needle receptacles extendable laterally from the shaft;
7 a flexible filament extending between the needle receptacles of the foot;
8 a plurality of needles advanceable distally and laterally from the shaft,
9 through the vessel wall outside the puncture, and to the needle receptacles of the foot.

1 38. The system of claim 37, further comprising a plurality of fittings
2 disposed adjacent the receptacles of the foot, the fittings securely engaging the needles
3 so that the needles, fittings, and at least a portion of the filament can be withdrawn
4 through the vessel wall along at least one of the needle paths formed by the needles
5 without threading the filament into the needles.

1 39. The system of claim 37, wherein the foot comprises an elongate
2 body defining an axis, the foot articulatable from a small profile configuration to a large
3 profile configuration by actuating the proximal handle so that the foot slides axially and
4 pivots laterally within the vessel.

1 40. A system for suturing a puncture of a blood vessel within a tissue
2 tract, the vessel having a vessel wall, the system comprising:
3 a shaft having a proximal handle and a distal end suitable for insertion
4 along the tissue tract and into the vessel through the puncture;
5 a foot mounted near the distal end of the shaft, the foot having a first
6 needle receptacle and articulatable from a small profile configuration to a large profile
7 configuration by actuation of the handle;
8 a first fitting removably mounted adjacent the first needle receptacle;
9 filament coupled to the first fitting; and
10 a first needle advanceable from the shaft to the first needle receptacle on
11 the articulated foot, the first fitting securely engaging the first needle so that the secured
12 first fitting and at least a portion of the filament can be withdrawn through the vessel wall
13 by the first needle.

1 41. The system of claim 40, wherein the filament comprises a suture
2 and couples the first fitting to a second fitting, and further comprising a second receptacle
3 disposed near the distal end of the shaft and a second needle advanceable from the shaft
4 to the receptacle to withdraw the second fitting proximally through the vessel wall and
5 form a suture loop across the puncture.

1 42. The system of claim 40, further comprising a second receptacle
2 disposed near the distal end of the shaft, a second fitting coupled to the filament and
3 disposed within the second receptacle, a second needle adapted to form a second needle
4 path through the vessel wall and having a suture releasably mounted thereon, wherein the
5 second fitting couples the filament to the suture so that the suture can be withdrawn
6 proximally along a first needle path through the vessel wall formed by the first needle to
7 form a suture loop across the puncture.

1 43. The system of claim 42, wherein a loop is releasably supported
2 about a first needle port, the first needle advancing from the first needle port so that
3 tensioning the withdrawn suture secures a knot in the suture loop.

1 44. The system of claim 40, further comprising a sensor near the distal
2 end of the shaft to indicate when the shaft extends into the vessel, and wherein the
3 deployed foot can engage an inner surface of the vessel wall when the shaft is withdrawn
4 proximally to help axially position the shaft.

1 45. A probe for suturing an opening in a tissue, the probe comprising:
2 a shaft having a proximal end and a distal end and defining an axis
3 therebetween, the shaft having a size and configuration suitable for insertion through the
4 opening in the tissue;
5 an elongate foot movably mounted to the shaft;
6 an actuator extending along the shaft distally to the foot, movement of the
7 actuator sliding the foot axially and pivoting the foot from a low profile configuration
8 aligned along the shaft to a deployed configuration extending laterally from the shaft;
9 a suture supported by the foot; and
10 a needle advanceable from the shaft through the tissue and to the deployed
11 foot.

1 46. The probe of claim 45, wherein the foot has a first end and a
2 second end, and wherein a plurality of needles are extendable from the shaft to the ends
3 of the foot.

1 47. The probe of claim 46, wherein a first length of suture extends
2 between a first fitting at the first end of the probe to a second fitting at the second end of
3 the probe, and wherein a second length of suture extends from a third fitting at the first
4 end of the probe to a forth fitting at the second end of the probe, and wherein each fitting
5 securingly engages an associated needle to draw ends of the first and second length of
6 suture through the vessel wall and form a plurality of loops across the puncture.